

16.—The Birds of Rottnest Island

For its size (4,726 acres) Rottnest has a disproportionately varied and abundant avifauna, the reason for which is not hard to find. The outstanding feature of the Island is its multiplicity of habitats: steppe, dune scrub, tall scrub, samphire, salt-lakes, brackish swamps, fresh-water soaks, sandy beaches, rocky coasts and offshore islets and stacks. In addition there are the man-made habitats of tuart plantations and grassy clearings.

Systematic accounts of the birds of Rottnest have been written by F. Lawson [Whitlock] (1905), Glauert (1929), and Serventy (1938). In the present paper the birds will be discussed under headings of major habitats.

Open Country

Steppe (dominated by *Acanthocarpus* and tussock grass) is now the widest-spread plant formation on the island. Its chief bird inhabitants are the Pipit (*Anthus novaezeelandiae*), White-fronted Chat (*Epthianura albigrons*), Raven (*Corvus coronoides*), Kestrel (*Falco cenchroides*), and the introduced Pheasant (*Phasianus colchicus*). A surprising absentee is the Black-faced Wood-Swallow (*Artamus cinereus*), which occurs in similar situations along the mainland coast.

Scrub

As on the mainland, dune scrub (*Olearia axillaris* etc.) supports very few species. Only the Singing Honeyeater (*Meliphaga virescens*) is common here. The Spotted Scrub-Wren (*Sericornis maculatus*) is now quite rare.

A more varied fauna occupies the tall scrub (*Acacia rostellifera*, *Templetonia retusa*, etc.), but as this formation is being rapidly replaced by steppe most of its birds are declining. Indeed, two species, the Brush Bronzewing (*Phaps elegans*) and the Rufous Whistler (*Pachycephala rufiventris*) have already disappeared from the island, while the numbers of Golden Whistler (*P. pectoralis*) and Red-capped Robin (*Petroica goodenovii*) are steadily decreasing. The presence on Rottnest of the latter is remarkable, for the opposite mainland is occupied by the Scarlet Robin (*P. multicolor*), which is replaced by *goodenovii* only in the drier country north and east of the jarrah forest. The Western Silvereye (*Zosterops gouldii*) alone is abundant; significantly one of its major food items is the purple fruit of *Solanum simile*, a plant favoured by fire and disturbance generally. Largely confined to the *Templetonia* scrub west of the salt-works is a small colony of Peafowl (*Pavo cristatus*), descendants of birds liberated from the Zoological Gardens about 1912. The two introduced turtle-doves (*Streptopelia senegalensis* and *S. chinensis*) are not strictly scrub-birds; they favour isolated thickets and the contiguous grassland.

Woodland

Woodland is a minor component of the vegetation of Rottnest and accordingly few birds are found in it. The Fan-tailed Cuckoo (*Cacomantis*

flabelliformis) is a common visitor in winter and spring to the groves of teatree (*Melaleuca pubescens*) on the eastern end of the island; whereas around Perth its status seems to be merely that of a passage migrant. The wooded margins of swamps and lakes are the principal habitat of the Sacred Kingfisher (*Halcyon sancta*). Large teatrees are the favourite roosting sites of pheasants and ravens, the latter commonly nesting in them. The widespread planting of tuarts (*Eucalyptus gomphocphala*) has provided a niche for the Western Warbler (*Gerygone fusca*), which has recently become established on the eastern end of Rottnest.

Lakes and Swamps

It is on or around the salt-lakes that one finds the greatest concentration of birds. Throughout the year certain of the lakes (especially Government House and Serpentine) support enormous numbers of brine shrimps (*Artemia salina*), which in turn provide abundant food for breeding Silver Gulls (*Larus novaehollandiae*) and Mountain Ducks (*Tadorna tadornoides*). The Banded Stilts (*Cladorhynchus leucoccephalus*) that visit the Island in summer feed exclusively on these crustaceans.

The shores of the lakes are occupied in summer by huge flocks of birds that breed in northern Asia; they are composed of the following species (in order of decreasing abundance): Little Stint (*Calidris ruficollis*), Curlew Sandpiper (*Calidris ferruginea*), Turnstone (*Arenaria interpres*), Sanderling (*Crocethia alba*), Large Sand-Dotterel (*Charadrius leschenaultii*), Sharp-tailed Sandpiper (*Calidris acuminata*), Hooded Dotterel (*Charadrius cucullatus*), Greenshank (*Tringa nebularia*), and Golden Plover (*Pluvialis dominica*). The only resident shorebird is the Red-capped Dotterel (*Charadrius alexandrinus*). Exposed shell-banks are the chief nesting site of the Rottnest population of Fairy Terns (*Sterna nereis*). The ubiquitous Welcome Swallow (*Hirundo neoxena*) is most abundant in the vicinity of the lakes, where myriads of flying insects assure it of a regular supply of food.

Fresh and brackish waters support far fewer species. Outside the breeding season the White-faced Heron (*Notophya novaehollandiae*) is a common visitor to the Island. Grey Teal (*Anas gibberifrons*) are less frequent. Recently established on Rottnest, the Banded Plover (*Zonifer tricolor*) usually breeds on grassy flats beside fresh-water swamps. Rock Parrots (*Neophema petrophila*) drink at the soaks and obtain much of their food (e.g. samphire seeds) in the vicinity, but for nesting they resort to the offshore islets.

Coast and Islets

Much smaller numbers of limicoline birds are found on the coast than around the lakes. Sandy beaches are occupied by the Pied Oystercatcher (*Haematopus ostralegus*) and the Red-capped Dotterel, both of which are resident, and a few migratory species, especially the Little Stint, Sanderling, and Large Sand-Dotterel. The Turnstone, Grey Plover (*Squatarola squatarola*),

and Whimbrel (*Numenius phaeopus*) prefer rocky shores. At low tide, Reef Herons (*Demigretta sacra*) may be seen on the fringing reefs.

Several marine species nest on offshore stacks and islets, viz: Osprey (*Pandion haliaeetus*), Silver Gull (*Larus novaehollandiae*), Crested Tern (*Sterna bergii*), Bridled Tern (*S. anaetheta*), Caspian Tern (*Hydroprogne caspia*), Pied

Shag (*Phalacrocorax varius*), and Wedge-tailed Shearwater (*Puffinus pacificus*), though the largest breeding colony of the last-named is on the main island at Cape Vlaming. Non-breeding but regular visitors to the seas off Rottneest include the Gannet (*Sula serrator*) and Arctic Skua (*Stercorarius parasiticus*).

D. L. SERVENTY and G. M. STORR.

17.—The Salt Lakes of Rottneest Island

The salt lakes cover some 500 acres at the eastern end of the Island and separate the settlement area from the main part of the Island. At their highest level in August the four main lakes and Garden Lake are continuous. However water lies over the bar between Bagdad and Herschell Lakes only very briefly, and in summer not only does a bar separate Serpentine from Government House Lake, but other smaller portions of the lakes are cut off. Water passes freely through the built up causeway between Herschell and Government House Lakes.

The seasonal change in water level is marked. The highest winter level (August) is 2.8 ft above zero on the Fremantle tidal datum (fixed at lowest low water). By March the level of Lake Bagdad has fallen to +0.5 ft ('57, '58, '59), Herschell and Government House Lakes to -0.5 ft and the main Serpentine Lake to +1.0 ft ('59). Monthly mean sea level varies from 2.8 ft in winter (June) to 2.1 ft in summer (October to January); the lakes are thus below sea level for most of the year.

The lakes have wide, gently sloping littoral fringes and are of no great depth so that the seasonal evaporation results in considerable concentration of the salts. Chlorinity figures for the 1958-59 season are thus shown below:—

Lake	Approx. Depth	Chlorinity, parts per thousand			
		14/9/58	26/11/58	9/2/59	22/3/59
	ft.				
Bagdad	8	43	51	67	63
Herschell	16	55	60	73	76
Garden	32	38	60	67
Govt. House	20	65	70	84	88
Pink	27	46	158	182

There is considerable seepage into the lakes and this shows as a film of water between high and low lake levels. The principal areas of seepage are shown on the map. Most are fresh, with chlorinities between 0.5 and 3.0‰, some are brackish and one, on the north shore of Lake Bagdad at its nearest point to the sea, approximates the chlorinity of sea water (19.0‰).

The three small western lakes are shallow and Negri and Sirius dry out each summer; from the biological point of view they are best regarded

as brackish. The western part of Government House Lake becomes cut off and may also dry out; until recently the salt from this was harvested commercially.

There is no macroscopic plant life in the salt lakes apart from an algal film on the rocks and the spheres of *Botryococcus macropogon* (Xanthophyceae) that are washed up on the shores. *Lamprothamnion macropogon* (Charales) grows in the brackish lakes.

The fauna of the lakes is very restricted in number of species. *Artemia salina* is the principal planktonic animal. It is present in the three large lakes and Garden Lake but is particularly abundant in Government House Lake where the water on the leeward side is often coloured pink by the animals. Chironomid larvae (*Tanytarsus* sp.) and the larvae and pupae of an ephydrid fly are abundant in the algal film on the rocks round the lake margins and at times free in the water. Hydrophillid and dytiscid larvae and adults and the larvae of a trichopteran *Symphitoneuria wheeleri* occur seasonally. Isopods are common under loose stones.

The brackish water gastropod *Coxiella striatula* is abundant in lakes Negri and Sirius; Macpherson (1957) records the type locality of this species as "Lake Ursula," a name used by Mr. Glauert for the seasonal pool in Rifle Range swamp. The crab *Brachynotus octodentatus* occurs in brackish seepage at north Bagdad Lake; this species is common in brackish waters along the south coast of Western Australia. Chironomid larvae, amphipods and ostracods are common in the seepages.

There are extensive shell deposits round the lake margins, both consolidated in the littoral shelves and as unconsolidated material at up to 12 ft above lake level. They are composed largely of lamellibranchs; *Katelysia scalarina* and *Venerupis* sp. appear to be the most abundant, and *Hormomya* sp. nov. is also plentiful. Several species of gastropod are common, including *Notoacmea onychitis* and three species of the small *Diala*; *Eubittium lawleyanum* is abundant in the upper part of some deposits and this appears to have been mistaken for *Coxiella* by Teichert (1950).

In many places there are undercut cliffs near the lake edges similar to the intertidal undercuts of the ocean coasts, and at the same level; they are illustrated by Teichert (1950). The existence of these makes it certain that the lakes were connected to the sea at a time when sea level was little different from the present. Most of the common species of the shell deposits still live in coastal waters near Fremantle (principally

in the shelter of Cockburn Sound). Of the others, many, e.g. *Katelaysia* spp., are common along the south coast of W.A. and a few are known only from the north west (Shark Bay). Most live in sand or silt but both *Notacmea* and *Hermomya* live on rocky shores. The fauna is that of a marine gulf under stable conditions of temperature and salinity (G. Kendrick, in lit.).

E. P. HODGKIN.

18.—Fresh Water and Brackish Water Swamps of Rottnest Island

These swamps lie in the eastern half of the Island and, in comparison with the salt lakes, have a very limited area. Most of the larger swamps (Lighthouse, Salmon, Barkers, Bulldozer, Bickley, Rifle Range and Parrakeet) are situated in interdune depressions. Aerodrome Swamp was however, originally part of Government House Lake; it was isolated during the construction of the aerodrome in 1943 and is now much less saline. Corio Pool and the two small Garden Pools lie adjacent to salt lakes and, like the seepages round the lakes, appear to be fed by a seasonally variable seepage. In addition to these waters, there are some wells which act as breeding sites for mosquitoes.

Two important factors affect the biology of the swamps.

(a) Water is generally present only during the winter; the ponds fill near the time of the first heavy winter rains in May or June and the last free water evaporates with the higher temperatures of late October and November. Pools in Bickley Swamp and Aerodrome Swamp may retain water through summer and even in the shorter lived swamps the soil remains moister than in the surrounding dunes.

(b) The water of some swamps is brackish and shows marked seasonal changes in salinity.

Apart from research on frogs and some preliminary studies on dragonflies, no study has been made of the faunal succession of the Rottnest swamps. The frogs have been studied by members of the Zoology Department as part of investigations of the Western Australian amphibian fauna, and the results will be published elsewhere in the near future.

Collections were made from all the freshwaters in October, 1958. Unfortunately, identification of the material is still incomplete, but Table 1 shows the distribution of animal groups. It is evident that not only is the total fauna a restricted one, but that it differs from one swamp to another. It is clear also that animals maintaining populations in the temporary swamps must show certain adaptive characters in relation to the factors mentioned above. (a) They must either aestivate as a drought resistant stage or recolonise the ponds annually from the mainland. All the Crustacea belong to groups known to have aestivating eggs, with the exception of the amphipod, which is the littoral rockpool talitrid, *Hyale rubra* (kindly identified by Dr. K. Sheard). In contrast, larval dragonflies (*Anisoptera*) cannot withstand drying and annual recolonisation occurs; successful breeding depends on rapid growth, but in years when the ponds are short lived, breeding is frequently unsuccessful (Hodgkin and Watson 1958). (b) They must be able to withstand some degree of salinity; the capacity for osmoregulation being important in the range of swamps inhabited. Investigations of the fauna of the Rottnest swamps must give valuable information relative to adaptation to seasonal aridity and to salinity and may also throw light on divergence from the mainland swamp fauna.

D. H. EDWARD and J. A. L. WATSON.

Reference

Hodgkin, E. P., and Watson, J. A. L. (1958).—Breeding of dragonflies in temporary waters. *Nature Lond.* 181: 1015-1016.

19.—The Littoral Environment of Rottnest Island

Fauna and flora of the rocky shores of the Island have been studied over many years and are now fairly well known. Sandy bays and beaches, and the abundant life of the sublittoral rocks have, however, received little attention. Zonation of the animal and plant life of the intertidal limestone platforms, in relation to tide levels and exposure to wave action, has been the particular interest of the writers. Surveys have been made over a number of years; the results have been presented as theses (Marsh 1955, and Smith 1952) and are in preparation for publication.

Tidal range is small, maximum daily range is about 3 ft and extreme range about 5 ft, sea level being influenced by air pressure, water temperature, and prevailing winds (Hodgkin and Di Lollo 1958). Sea temperature varies remarkably little; it rarely exceeds 23° C or is less than 18° C. The water is generally very clear and estuarine water from the Swan River rarely reaches the east end of the Island, even during heavy winter rains.

Sandy bays and rocky headlands with intertidal platforms alternate around the 20 miles of coastline and narrow limestone bars, barely